Biological, Chemical, and Physical Observations of Lake Huron Submerged Sinkholes

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PROJECT HISTORY

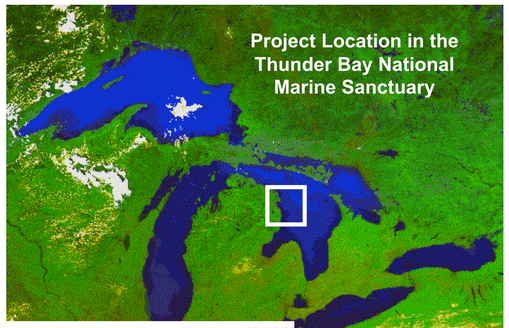
2001 Thunder Bay National Marine Sanctuary and Institute for Exploration Shipwreck Survey leads to discovery of karst features 88 m and deeper.

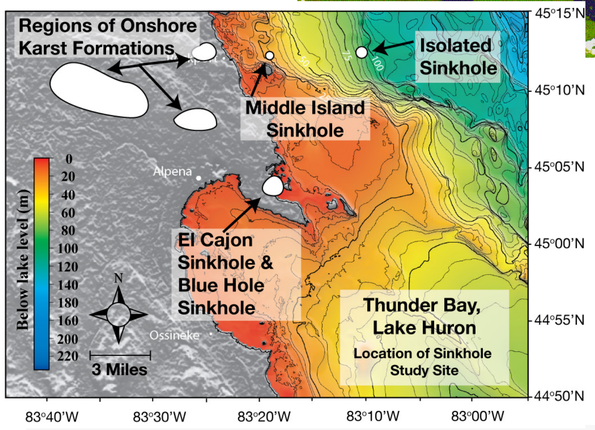
2003 Isolated Sinkhole Project - Biology, Chemistry, Mapping.

2004 Isolated Sinkhole Mapping and Benthic Sampling - plume absent.

2006 NSF Project - Middle Island and El Cajon Spring Biology and Mapping.

2008 NOAA Ocean Exploration Project - Offshore and Nearshore Sinkhole Biology, Mapping, and Time Series.





Mapping and Water Sampling Methods

Positioning System: TrackLink 1500HA 31– 43.2 kHz with a 120 degree beamwidth, slant range accuracy of 0.2 m and positioning accuracy of 0.25 degrees.

CTD: SBE19 measuring temperature, conductivity, and depth.

Time referenced CTD and acoustic positioning data (UTM format) merged to plot contoured color visualizations.

GOALS

-Understand submerged sinkhole habitats (light, dissolved oxygen, nutrients).

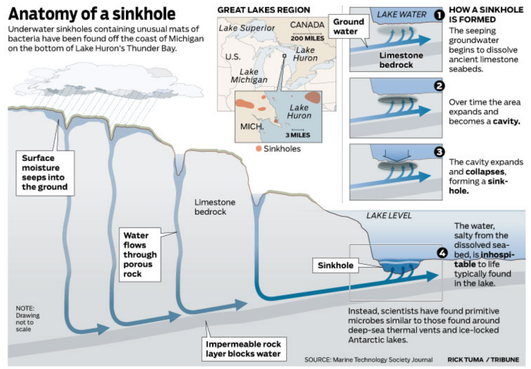
-Understanding groundwater flow into these systems.

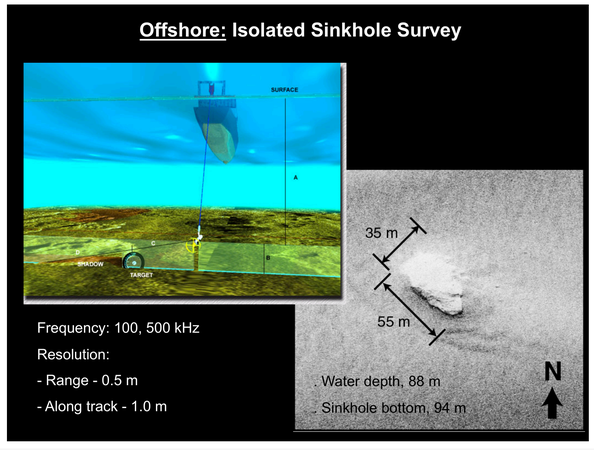
-Explore submerged karst system chemistry, biology, and physics in the time-domain.

- Obtain spatial understanding of submerged karst systems through physical-chemical mapping, bathymetric maps (multi-beam), and geologic mapping (sub-bottom profiles).

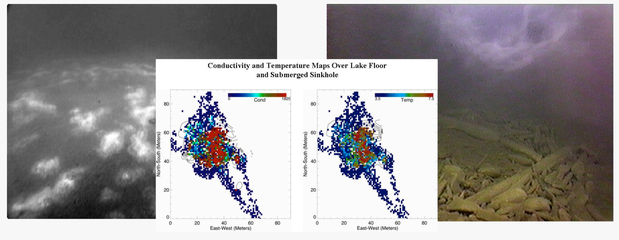
-Goals contribute to Sanctuary interpretation, water levels, and continued understanding of these unique ecosystems.

Silurian-Devonian Aquifer



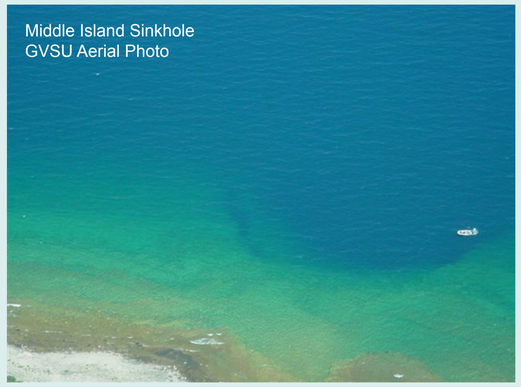


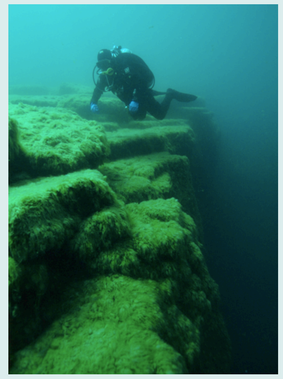
Results of 2003 Isolated Sinkhole Survey



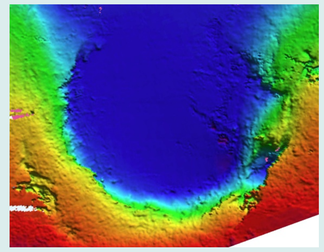
Parameter	Lake	Vent
Conductivity	140	1700
Temperature	3.5	7.0
Chloride	13	175
Sulfate (mg/L)	16	1457
Total P (mg/L)	0.004	3.230
DOC (mg/L)	2.5	9.8
POC (mg/L)	0.9	405

- **Aphotic sinkhole system**
- **Non-photosynthetic benthic microbial mats.**
- **Bacterial concentrations (~9x10^9 cells l-1) an order of magnitude higher than ambient.**
- **Evidence for the occurrence of significant chemosynthesis.**

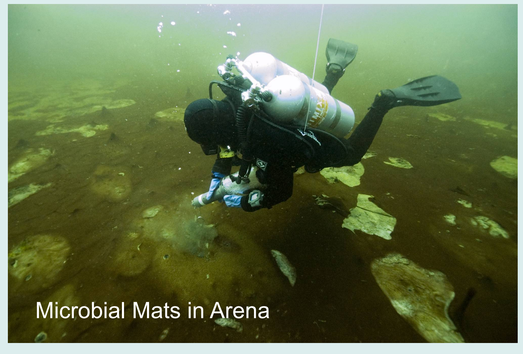


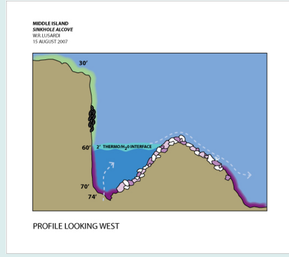


Middle Island Ledge and Alcove

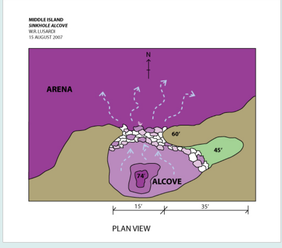


- Estimated flow from the Alcove ~ 0.8 m^3/s (28 cfs)
- Time series temperature average at 1m hab in the Arena - 9.94 C
- Arena sediment thickness measured with sub-bottom acoustics ~ 17.4m





Middle Island Arena and Alcove



FUTURE

Ocean Exploration and NSF Proposals.

Comparative exploration of Huron, Michigan, and Erie sinkhole systems.

- time domain observations.
- diversity of biological communities.
- acoustic mapping.
- comparative microbiology and genetic diversity.
- assess biotechnical and pharmaceutical application of microbes.

Examine evolutionary implications of cyanobacteria.